

U.S. Patent Application For

**RETRACTABLE DISPLAY MODULE**

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## RETRACTABLE DISPLAY MODULE

### FIELD OF THE INVENTION

5           The present invention relates generally to a retractable display module, and particularly to a retractable display module utilized with servers and other processor-based devices.

### BACKGROUND OF THE INVENTION

10           In many processor-based devices, e.g. servers, chassis size and overall package size has been reduced to conserve physical space requirements. For example, some servers have been designed with a one unit or 1U profile that  
15           results in a thin or low overall package. Accordingly it has become more difficult to provide numerous features at the front portion of such devices. Often, it is desirable to provide a display screen, such as an LCD display, that can provide an operator with a variety of information about  
20           the operation of the device or components within the device. However, conventional displays require substantial space at the front of the device.

          It would be advantageous to have a display that could  
25           be removed to a space-conserving location when not in use.

SUMMARY OF THE INVENTION

According to one aspect of the present invention, a server is provided with a retractable LCD module. The LCD module may be moved between a retracted position within the chassis of the server and an open position where the display is visible. In one embodiment, the LCD module is pivoted to a position generally perpendicular to the front of the server and retracted into a narrow guide housing.

According to another aspect of the invention, an information display module is incorporated into a processor-based device. The information display module may be an LCD module movable between a retracted, space-conserving position and an open, visible position. In one embodiment, the information display module may be pivoted from its open position to a position generally perpendicular to the front of the device. Also, the information display module may be resiliently biased to its retracted position.

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According to another aspect of the invention, a method is provided for conserving space at the front of a processor-based device, such as a server. The method includes storing a display module in a guide housing within

the device when the display module is not in use. The method further includes removing the display module to an open position where it can be used. In an exemplary embodiment, the display module is an LCD module stored in a position generally perpendicular to the front of the device. However, the display module can be pulled from its storage position and pivoted to a visible position at the front of the device.

10

**BRIEF DESCRIPTION OF THE DRAWINGS**

The invention will hereafter be described with reference to the accompanying drawings, wherein like reference numerals denote like elements, and:

15

Figure 1 is a perspective view of a rack with a plurality of processor-based devices, e.g. servers, mounted therein;

Figure 2 is a front view of a low profile server;

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Figure 3 is a partially exploded perspective view of the server illustrated in Figure 2;

Figure 4 is a cross-sectional view taken generally along line 4-4 of Figure 3;

Figure 5 is a perspective view of a cable tray  
5 disposed within the chassis of an exemplary server;

Figure 6 is a cross-sectional view taken generally along line 6-6 of Figure 5;

10 Figure 7 is a perspective view of a PCI card riser assembly designed for mounting in a low profile chassis of an exemplary server;

15 Figure 8 is a cross-sectional view of the PCI card assembly taken generally along line 8-8 of Figure 7;

Figure 9 is a cross-sectional view similar to Figure 8 but showing the PCI card assembly in an eject position;

20 Figure 10 is a perspective view of the right end of the riser assembly illustrated in Figure 7;

Figure 10A is a perspective bottom view of the riser assembly illustrated in Figure 7;

Figure 11 is a partial front view of an exemplary server illustrating an indicator;

5        Figure 12 is partial rear view of an exemplary server illustrating a rear indicator;

Figure 13 is a circuit diagram for use with the indicators illustrated in Figures 11 and 12;

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Figure 13a is a diagram representing the functionality of the circuit illustrated in Figure 13;

Figure 14 is a perspective view of a retractable LCD  
15    module in a retracted position within an exemplary server;

Figure 15 is a perspective view of the retractable LCD unit illustrated in Figure 14 but in an open or operable position;

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Figure 16 is a top view of the LCD unit in an open position;

Figure 17 is a top view similar to Figure 16 but with the LCD unit in a retracted position;

Figure 18 is a top view of a cable management system  
5 deployed with an exemplary server that is retracted in a rack;

Figure 19 is a top view of the cable management system illustrated in Figure 18 with the exemplary server extended  
10 from the rack;

Figure 20 is a perspective view of a portion of an exemplary rack and rail; and

15 Figure 21 is an exploded view of an end of the rail illustrated in Figure 20.

#### **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

Referring generally to Figure 1, an exemplary  
20 implementation of the present invention is illustrated. In this embodiment, a plurality of densely packaged, processor-based devices 30 are shown mounted in a rack system 32. Rack system 32 is designed to slidably receive a plurality of the processor-based devices 30. Typically,

devices 30 are mounted on retractable rails that permit the device to be moved between a retracted position within rack 32 and an extended position in which the device is at least partially extended from rack system 32. This extension  
5 allows removal or servicing of an individual device 30, as illustrated in Figure 1.

Throughout this description, an exemplary processor-based device is described and referenced as server 30, but  
10 other devices also can benefit from the unique features described herein. The exemplary server 30 is a low profile server, such as a 1U server designed to occupy one unit of vertical space in rack system 32.

15 Server 30 includes a chassis 34 having a front 35 designed with pair of drive bays 36. Drive bays 36 are configured to receive a pair of hot pluggable drives 38. The front of chassis 34 also may be designed to receive an ejectable CD drive assembly 40 and an ejectable floppy  
20 drive assembly 42. In the particular design illustrated, CD drive assembly 40 and floppy drive assembly 42 are combined and removable or insertable as a single unit. The exemplary design also includes other features, such as a



retractable liquid crystal display (LCD) 44 and an indicator panel 46.

In server 30, components are densely packaged, but  
5 adequate cooling of the components is maintained. As  
illustrated in Figure 3, chassis 34 is divided into at  
least two general zones, including a high pressure, high  
airflow zone 48 and a relatively low pressure, low flow  
zone 50. An airflow is created into high pressure zone 48  
10 by a blower assembly 52. Blower assembly 52 typically  
includes a fan 54, such as a centrifugal fan, e.g. an  
exemplary blower unit is a 24 volt Gamma blower.  
Similarly, airflow through low pressure zone 50 is created  
by a blower 56. In the embodiment illustrated, blower 56  
15 comprises a fan integral with an internal power supply 58  
oriented such that its fan discharges airflow into low  
pressure zone 50.

Preferably, blower assembly 52 discharges airflow at a  
20 greater rate and pressure than blower 56. Thus, the air  
pressure created in high pressure zone 48 is maintained at  
a higher level than the air pressure in low pressure zone  
50 during operation of the fans. This ensures sufficient

airflow across densely packed, heat producing components disposed within high pressure zone 48 of chassis 34.

To ensure that minimal high pressure air from zone 48  
5 flows into low pressure zone 50, open areas between the zones have been blocked by an air baffle 60. Air baffle 60 prevents the output of blower assembly 52 from disrupting the air flow created through low pressure zone 50 by blower 56.

10

Exemplary components disposed in high pressure zone 48 include one or more, e.g. two, processors 62, each coupled to a corresponding heat sink 64. Each heat sink 64 includes a plurality of cooling fins 66 that decrease in  
15 height along an inwardly directed end to provide additional room for other components. For example, a plurality of memory modules 68, e.g. DIMMs, may be mounted within high pressure zone 48 at an angle to facilitate the low profile design of chassis 34. In this embodiment, memory modules  
20 68 are disposed at an angle over at least one of the heat sinks 64, but the decreasing height of the inwardly disposed cooling fins permit the memory modules to be so oriented without contacting the heat sink. Another

exemplary component disposed in high pressure zone 48 is a PCI card 70.

In operation, blower assembly 52 draws air in along  
5 drives 38 and discharges the airflow into high pressure  
zone 48. The size and capacity of the fan is adjusted  
according to the size of chassis 34 and the layout of  
components disposed in high pressure zone 48. However, the  
capacity should be sufficient to create enough pressure in  
10 high pressure zone 48 that the necessary quantity of  
cooling air passes across the components disposed in zone  
48, e.g. heat sinks 64 and memory modules 68.

Preferably, the airflow is discharged towards the rear  
15 of chassis 34. In the illustrated embodiment, chassis 34  
includes a cutout region 72 for receiving an air outlet or  
vent through which air is discharged from high pressure  
zone 48. For example, a vent region 74 may be disposed in  
a cover 76 designed to fit over chassis 34 and enclose high  
20 pressure zone 48 and low pressure zone 50. Vent region 74  
is disposed in a "scooped" region 78 of cover 76. When  
cover 76 is disposed on chassis 34, scooped region 78  
extends inwardly into the interior of chassis 34 in high  
pressure zone 48 along cutout region 72. As illustrated

best in Figure 5, vent region 74 includes a vent and preferably a plurality of vents 80 that permit the airflow to exit generally in a direction in line with the discharge from blower assembly 52. Exemplary vents 80 are formed as  
5 a plurality of louvers along scooped region 78.

Cover 76 also may include an air inlet 82 and an air outlet 84 for blower 56, or alternatively, inlet 82 and outlet 84 can be formed through chassis 34. As blower 56  
10 is operated, air is drawn through inlet 82 along the combined CD/floppy drive and into the power supply assembly 58. The air is discharged from blower 56 into low pressure zone 50 until it exits through outlet 84. Low pressure zone 50 may include a variety of components that vary  
15 according to the design of chassis 34 and server 30. In the exemplary embodiment, low pressure zone 50 includes a PCI card 86, an inline EMI filter 88 and an internal array controller cable tray 90.

20 Other features of server 30 include a dual PCI card and an ejectable riser assembly 92 to which PCI cards 70 and 86 are attached. Also, DIMM modules 68 and processors 62 preferably are attached to a motherboard 94. Drives 38 are coupled to a removable SCSI back plane 96. A raid on a

chip (ROC) board 98 is disposed intermediate blower  
assembly 52 and power supply 58. A power switch and LED PC  
board 100 is deployed within chassis 34 generally proximate  
indicator panel 46 for cooperation therewith. A back plane  
5 102 for the combined CD and floppy assembly is deployed  
between floppy drive assembly 42/CD assembly 40 and power  
supply 58. Additionally, a pair of mounting rails 104 can  
be attached to the sides of chassis 34 to permit engagement  
with corresponding rails of rack system 32, as described  
10 below. It should be noted that a variety of component  
arrangements can be utilized, however, the exemplary  
illustrated arrangement provides for a dense packaging of  
components separated into two cooling zones that are able  
to readily maintain the components at desirable operating  
15 temperatures. Several of the unique, inventive features  
that facilitate the above-described packaging are described  
below.

One of the unique features of server 30 is cable tray  
20 90. In low profile servers, such as the illustrated 1U  
server, larger SCSI cables can interfere with the fit of  
internal components as well as being detrimental to thermal  
performance, e.g. heat removal. Cable tray 90 is designed  
to hold an SCSI cable 106 and to lie generally flat along a

floor 108 of chassis 34. The low profile tray holds cable 106 substantially out of the airflow through low pressure zone 50. Thus, cable 106 can be used to form an electrical connection between a PCI card and motherboard 94 without  
5 interrupting airflow and thermal performance. Preferably, cable tray 90 includes a flat base 109 and a plurality of tabs 110 that extend over and retain cable 106, as illustrated in Figures 5 and 6. Preferably, tabs 110 extend upwardly from flat base 109 and may be integrally  
10 formed with flat base 109, as by plastic injection molding.

In the particular embodiment illustrated, SCSI cable 106 is connected to the board edge of motherboard 94 by an SCSI connector 112. Electrically, a control signal is  
15 implemented on an internal SCSI connector for an adapter to electrically switch the signal paths from being driven by an onboard controller to being driven by the adapter controller. The signal path preferably is optimized so that when no adapters are plugged in, there will be  
20 negligible impact on the signal quality.

Another feature that facilitates the dense packaging of components within chassis 34 is riser assembly 92, illustrated best in Figures 7 through 10A. The design of

riser assembly 92 permits the mounting of at least two full length PCI cards, such as PCI cards 70 and 86, as illustrated in Figures 8 through 10. Riser assembly 92 includes a framework 120 having a center frame portion 122  
5 disposed between PCI cards 70 and 86 and a pair of frame ends 124, 126 that are disposed generally perpendicular to center frame portion 122. Frame ends 124 and 126 preferably are spaced apart to slidably receive PCI cards 70 and 86. Typically, each frame end 124 and 126 includes  
10 appropriate supports 128 for supporting each PCI card.

Additionally, riser assembly 92 includes a PCI riser card 130 disposed along center frame portion 122. A pair of oppositely facing connectors 132 are electrically  
15 coupled to PCI riser card 130 and extend in opposite directions therefrom for coupling with PCI card 70 and PCI card 86. Connectors 132 are mounted to PCI riser card 130 in a vertically staggered arrangement. Additionally, a riser card connector 134 is mounted to riser card 130 and  
20 configured for connection with motherboard 94 at a connection location 136 (see Figure 6) to permit communication with PCI cards 70 and 86.

Additionally, riser assembly 92 includes a lever and preferably a pair of levers 138 connected by a handle 140. Lever or levers 138 are pivotably mounted to riser assembly 92, preferably at center frame portion 122 for pivotable  
5 motion about a pivot mount 142. Each lever 138 also includes an engagement end 144 that has an engagement feature, such as a recess 146 designed to engage a rib 148, typically mounted on chassis floor 108 (see also Figure 6).

10 When riser assembly 92 is moved downwardly into chassis 34 (generally over cable tray 90), engagement end 144 and recess 146 engage rib 148, as illustrated best in Figure 9. Handle 140 is then pressed to pivot lever 138 about pivot 142, thereby driving riser card connector 134  
15 into engagement with a corresponding connector, e.g. a connector on motherboard 94, and riser assembly 92 into proper position. To remove riser assembly 92, handle 140 simply is pulled upwardly which moves riser assembly 92 and riser card connector 134 laterally to permit lifting of the  
20 entire assembly from chassis 34.

It should be noted that riser assembly 92 may be further secured in chassis 34 by a plurality of engagement features. For example, as illustrated in Figures 10 and



10A, a plurality of pins and receptor slots can be used to secure riser assembly 92 into chassis 34 when levers 138 are pivoted to an installed position. As illustrated in Figure 10, frame end 126 may be designed with a pin 150 and  
5 a receiving slot 152 that are located for engagement with a corresponding receiving slot 154 and pin 156, respectively, that are attached to chassis 34. In this embodiment, receiving slot 134 is formed in a tab 158 that extends upwardly from chassis floor 108, and pin 156 also is formed  
10 to extend generally upwardly from chassis floor 108 for sliding engagement with receiving slot 152.

As illustrated best in Figure 10A, riser assembly 92 may also include one or more, e.g. two, pegs 160 that  
15 extend generally downwardly from the bottom of center frame portion 122. Pegs 160 are located for engagement with corresponding slots 162 formed in a bracket 164 mounted to chassis floor 108 (see also Figure 6). Bracket 164 and slots 162 are designed to engage and retain pegs 160 when  
20 levers 138 move riser assembly 92 into its installed position, as illustrated best in Figure 8.

Another unique feature of server 30 is an indicator system 162 illustrated in Figures 11 through 13. Indicator

system 162 permits a technician to identify the appropriate server 30, or other processor-based device, that requires attention and to disconnect the unit without risking disconnection of the wrong unit.

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When multiple servers are mounted in a rack, particularly when the units have low profiles, such as 1U servers, it can be difficult for a technician to ensure that he or she unplugs the proper unit at the rear when the unit was initially identified from the front. Thus, indicator system 162 can be activated to provide an indicator of the desired server from the front of the server and from the rear of the server. A variety of tags, logos, audible indicators etc. could be activated by an actuator to provide appropriate designation of the server requiring attention.

However, a preferred indicator system 162 provides a front switch 164 and a front light 166, as illustrated in Figure 11. Similarly, exemplary indicator system 162 provides a rear switch 168 and a rear light 170, as illustrated in Figure 12. When either front switch 164 or rear switch 168 is depressed while lights 166 and 170 are off, both lights 166 and 170 are illuminated. If either

switch 164 or 168 is depressed while lights 166 and 170 are illuminated, both lights 166 and 170 turn off.

This allows an individual to identify a unit requiring  
5 attention from the front. Once identified, front switch  
164 is depressed to illuminate front light 166 and rear  
light 170. The individual may then walk around to the back  
of a rack containing multiple units, identify the unit  
having an illuminated rear light 170, and unplug cables  
10 from the unit. The unit then can be removed from the front  
of the rack for service or replacement. This prevents the  
inadvertent disconnection of the wrong unit. Lights 166  
and 170 preferably have a visually noticeable color, such  
as a blue color.

15

An exemplary circuit for use in indicator system 162  
is illustrated in Figure 13 and the functionality of the  
circuit is illustrated in Figure 13a. The exemplary  
circuit may be powered by an auxiliary power supply Vaux  
20 172. Power supply 172 may be separated from the main  
system power supply which allows the circuitry to be  
operated even when the main system power is off. Other  
components of the circuit include a NAND-gate 174, a D-  
flipflop 176 and an inverter 178.

In this exemplary embodiment, the D-flipflop 176 is illustrated after its reset condition, that is its output Q is low and Q/ is high. When either push button 164 or 168 is depressed, the signal line PUSH/ (labeled 172a) level changes from high to low. This signal transition causes the clock input signal, CLK 166d, of D-flipflop 176 to change from low to high, via NAND-gate 174. The clock signal latches the high state at the D input, therefore changing the Q output (labeled 166c) from low to high. Because the Q output signal is passed through the inverter 178, the signal (LED-ON/ 166a) at the cathode pins of LEDs 166 and 170 is changed from high to low. This turns on or illuminates LEDs 166 and 170. At this time, the D input of the flipflop 176 is low. When either push button 164 and or 168 is depressed again, the CLK input latches the low state from the D input, causing the Q output, STATUS 166c, to change from high to low. This transition goes through the inverter 178, effectively turning off both LED 166 and LED 170.

In the embodiment illustrated, one of the NAND-gate 174 inputs also can be controlled by software designed to allow LEDs 166 and 170 to be turned on, turned off or

blinking. Application software on the server or on a remote server can be utilized to control the state of the LEDs. The D-flipflop 176 output Q/, STATUS/ 166b, also can be monitored by software. This would allow a technician from  
5 a remote site to control the state of LEDs 166 and 170 and to notify another technician in the server room as to which server requires service. Upon completion of the service work, the servicing technician would then push either button 164 or 168. The remote technician is thereby able  
10 to monitor the LED status and to determine completion of the service work. It should be noted that the figure and functionality described are exemplary, and other circuits can be used to accomplish the device identification described above.

15

Another unique feature of the exemplary server 30 is the retractable LCD 44, illustrated in Figures 14 through 17. The liquid crystal display module 44 can be moved between a retracted position, as illustrated in Figure 14,  
20 and a display or open position, as illustrated in Figure 15. The LCD module includes a display 180 that can be used as a visual interface for various information related to the operation of server 30. However, when LCD module 44 is not in use, it can be moved to the retracted position to

permit access to CD drive assembly 40 and floppy drive assembly 42.

LCD module 44 is pivotably mounted to a retraction  
5 assembly 182 by a module pivot 184 that allows LCD module  
44 to be pivoted between the display position and a  
position generally perpendicular to the front of server 30  
for retraction. Retraction assembly 182 includes an outer  
guide housing 186 disposed generally between floppy drive  
10 assembly 42/CD drive assembly 40 and drive bays 36. Outer  
guide housing 186 is designed to slidably receive LCD  
module 44 therein.

Retraction assembly 182 further includes a pivot mount  
15 bracket 188 to which module 44 is pivotably mounted via  
pivot 184, as best illustrated in Figures 16 and 17.  
Generally opposite pivot 184, bracket 188 includes one or  
more attachment features 190 to which one or more resilient  
members, such as a pair of springs 192 can be attached.  
20 Preferably, a pair of springs positioned above and below  
each other are used to balance the biasing force on pivot  
mount bracket 188 and LCD module 44 as LCD module 44 is  
drawn into an open interior 194 of outer guide housing 186.  
Exemplary springs 192 include coil springs that are pulled

to a stretched position when LCD module is moved to its open or display position. Thus, the coil springs bias LCD module 44 back into open interior 194 when module 44 is pivoted to a position generally in alignment with open interior 194. An appropriate electric line or lines 195 may be routed to LCD module 44 through outer guide housing 186, as best illustrated in Figures 16 and 17.

When units, such as servers, are stacked sequentially in rack system 32, the various cables coupled to the various server ports can be difficult to manage. This is particularly true with low profile servers, such as 1U servers, due to the relatively large number of closely spaced units. Accordingly, the densely stacked servers benefit from a cable management system 200, such as that illustrated in Figures 18 and 19. The exemplary cable management system 200 includes a tray bracket 202 mounted to and extending rearwardly from each server 30. At least one and preferably a pair of spools 204 serve as a cable support member and are mounted to tray bracket 202 in a position that permits the plurality of various cables 206 to be wrapped and held generally along the backside of server 30. Spools 204 can be mounted in a variety of locations depending on the design of server 30 and rack

5           Cable management system 200 further includes a tension device 208 and a retainer member 210. Tension device 208 and retainer 210 preferably are mounted towards the back of rack system 32 generally on a level with server 30. Retainer 210 may be mounted or formed at a position on an opposite side of rack system 32 from tension device 208, as illustrated in Figures 18 and 19. Retainer 210 also is positioned slightly rearward of tension device 208.

comprises a tension reel 212, such as a torsion spring loaded reel, having an extensible member 214, such as a cord or cable. Extensible member 214 is connected to cable bundle 206 at a location intermediate the cable connectors plugged into the rear of server 30 and retainer 210.

Specifically, extensible member 214 is connected to cable bundle 206 generally intermediate the position at which cable bundle 206 is in contact with retainer 210 and the position of the closest spool 204. Thus, when a specific server 30 is slid to an extended position in rack system



32, extension member 214 is pulled outwardly, as  
illustrated in Figure 19. However, when the server is  
returned to its retracted position within rack system 32,  
extension member 214 is retracted into tension reel 212,  
5 thereby pulling cable bundle 206 to a neatly folded  
position to the rear of server 30, as illustrated in Figure  
18.

When multiple thin profile devices, e.g. servers, are  
10 mounted in a rack system 32, a rack rail must be positioned  
for engagement with the side mounting rails 104 attached to  
chassis 34 of each device 30. With low profile devices,  
multiple rails must be deployed in rack system 32 to  
receive the multiple corresponding servers. To facilitate  
15 assembly of rack system 32, and specifically the attachment  
of rack rails for supporting each device 30, unique rails  
have been designed for easy insertion and removal.

As illustrated best in Figure 20, a preferred rack  
20 system includes a front support member 220 and a back  
support member 222 on each side of rack system 32. Front  
support member 220 includes a plurality of mounting  
openings 224 that inhabit a substantial portion of the  
member. Similarly, rear support member 222 includes a

plurality of mounting openings 226 that extend upwardly for a substantial distance along the support member. The mounting openings are designed to receive a rail 228 that extends from the front to the rear of rack system 32

5 between front support member 220 and rear support member 222. It should be noted that mounting openings 224 and 226 can be in a variety of configurations and can be changed to mounting tabs, brackets or other features able to engage the corresponding mounting ends of each rail 228.

10

In the illustrated embodiment, each rail 228 includes a rear mounting end 230 and a front mounting 232. Each mounting end 230, 232 includes engagement features for engaging the mounting structures along front and rear  
15 support members 220, 222. In the exemplary, illustrated embodiment, rear mounting end 230 and front mounting end 232 each include a pair of tabs 234 sized and spaced for receipt in corresponding mounting openings 222. Thus, rail 228 may be positioned at multiple different locations along  
20 support members 220 and 222.

In the preferred embodiment, rear mounting end 230 is fixed and front mounting end 232 is resiliently movable. Alternatively, rear mounting end 230 can be made

resiliently movable, or both mounting ends can be made resiliently movable. Regardless, an exemplary resiliently movable mechanism 236 is illustrated best in Figure 21.

5           In this embodiment, rail 228 includes a first rail portion 238 and a second rail portion 240 that may be slidably coupled to first rail portion 238 by a plurality of pins or fasteners 242. As illustrated, second rail portion 240 is formed with a pair of slots through which  
10 pins 242 extend into contact with corresponding mounting brackets 244 disposed on the interior of first rail portion 238. Heads 246 of pins 242 retain second rail portion 240 slidably trapped against first rail portion 238. In this embodiment, front mounting end 232 is formed at the front  
15 of second rail portion 240 for selective, sliding movement into and out of engagement with mounting openings 224 of front support member 220. Front mounting end 232 may include a bumper 248 to buffer the contact between first rail portion 238 and second rail portion 240 when sliding  
20 second rail portion 240 farther into first rail portion 238.

To ensure that rear mounting end 230 and front mounting end 232 remain firmly connected to rear support

member 222 and front support member 220, respectively,  
second rail portion 240 is biased outwardly from first rail  
portion 238 by a biasing system 250. An exemplary biasing  
system 250 includes a coil spring 252 disposed within a  
5 channel 254 located on the interior of first rail portion  
238. An abutment tab 256 is disposed at an interior end of  
channel 254. A second abutment tab 258 extends inwardly  
from second rail portion 240 generally at an end of spring  
252 longitudinally opposite of abutment tab 256 when second  
10 rail portion 240 is slidably mounted to first rail portion  
238.

Thus, spring 252 biases second rail portion 240 and  
mounting end 232 in an outward direction to firmly move  
15 rear mounting end 230 and front mounting end 232 into  
engagement with rear support member 222 and front support  
member 220, respectively. However, rail 228 can quickly  
and easily be removed by overcoming the bias of spring 252  
and forcing second rail portion 240 to slide inwardly into  
20 first rail portion 238. This resilient, movable mechanism  
236 permits quick installation and removal of rails 228  
from rack system 32 to accommodate the mounting of multiple  
devices, such as servers without the use of screws or other  
types of fasteners.

The actual features of rails 228 by which each server  
30 is slidably mounted thereto depends on the configuration  
of mounting rails 104. However, a variety of available  
5 sliding rails 104 and corresponding mounting rails 228 can  
be utilized, as known to those of ordinary skill in the  
art.

It will be understood that the foregoing description  
10 is of preferred embodiments of this invention, and that the  
invention is not limited to the specific forms shown. For  
example, a variety of devices other than servers can  
benefit from the various features described herein; the  
configuration of the overall chassis and the location of  
15 components can be adjusted according to a specific  
application; the size and capacity of the blower assemblies  
can be adjusted according to each application; and a  
variety of materials can be utilized in the construction of  
various components described herein. These and other  
20 modifications may be made in the design and arrangement of  
the elements without departing from the scope of the  
invention as expressed in the appended claims.